Wavefront aberration measurements and corrections through thick tissue using fluorescent microsphere reference beacons.

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Public Summary:
We present a new method to directly measure and correct the aberrations introduced when imaging through thick biological tissue. A Shack-Hartmann wavefront sensor is used to directly measure the wavefront error induced by a Drosophila embryo. The wavefront measurements are taken by seeding the embryo with fluorescent microspheres used as "artificial guide-stars." The wavefront error is corrected in ten millisecond steps by applying the inverse to the wavefront error on a micro-electro-mechanical deformable mirror in the image path of the microscope. The results show that this new approach is capable of improving the Strehl ratio by 2 times on average and as high as 10 times when imaging through 100 microm of tissue. The results also show that the isoplanatic half-width is approximately 19 microm resulting in a corrected field of view 38 microm in diameter around the guide-star.

Scientific Abstract:
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